

Exploring Urban Heat Island Effect with Ground Cover Types & Surface

Temperature Changes

Urwah Abbas, Marym Abdelaal, Blair Burd, Somaitah Hoq

Kenner Discovery High School



Abstract

The urban heat island effect is a topic of concern. It causes urban cities to be hotter than rural areas. The reason for this project was to discover if the type of ground cover in an area can decrease or increase surface temperatures. This knowledge could be used to aid efforts against the urban heat island effect and consequential environmental effects. Data was accessed using the GLOBE advanced data retrieval tool. GLOBE protocols were used in the study to measure surface temperature of different ground covers during different seasons and over ten years. Dates, surface temperature conditions, times, and environmental conditions of the day were also recorded. The results from the data supports that the type of ground cover does affect surface temperatures.

Research Question

- Does the ground cover type affect the surrounding surface temperature?
- While it is used as a major indicator of the urban heat effect, rising surface temperatures also have direct impacts on the health of our planet. Higher surface temperatures resulting from the urban heat effect contribute to rising levels of pollution. It is also known to cause general reduced nighttime cooling temperatures and increased day time temperatures. This, in turn, increases illness and death rates for heat-related health issues and sickness, such as heat strokes. If the type of surface in an area can change or decrease surface temperatures, this knowledge could be used to aid in the ongoing battle against the urban heat effect and the impact it has on our world.

Introduction

Content Knowledge

The biggest challenge in our environment is the urban heat island effect, which causes urban cities to be hotter than rural areas. But there are ways to keep our urban areas cool; from planting on balconies to adding more greenery in streets and parking lots. Having more greenery in cities is extremely important as it reduces impervious material and replaces it with natural surfaces. "Build green infrastructure improvements into regular street upgrades and capital improvement projects to ensure continued investment in heat-reducing practices throughout your community."(EPA United States Environmental Protection Agency,8).

The urban heat island effect is caused by rapidly urbanizing areas, where land surfaces undergo extensive modifications due to the replacement of natural landscapes with impervious materials like concrete and asphalt. This helps absorb and emit heat more than natural surfaces, which causes many problems to human health, energy consumption, and overall sustainability of communities.

Human and pets health is very important in cities since many of them live in the city to work or to play. It causes overheating which causes heavy sweating and rapid pulse. It can even cause a pet to die. It can also cause heat exhaustion, that comes with heat camps, heat strokes, and hyperthermia. This problem also contributes to energy demand for cooling, which leads to higher greenhouse gas emissions.

Research Methods

Planning Investigations

The surface temperatures measured were taken on short grass, bare ground, and asphalt. Data was collected at different times during the year across a span of ten years. Surface temperature readings were taken on each surface each time. The data was collected daily at solar noon. Based on the data collected, an infrared thermometer(IRT) was used for surface temperature readings.

GLOBE Data Used

Data was accessed through the GLOBE advanced data access tool. Data was accessed from measurements taken from Roswell Middle School over ten years. This data was useful for research because of the location, extensive time data was collected, variety of ground covers included, and surface temperature readings. Thousands of data entries were downloaded. Over 900 data entries were used for the research project. This data used by making comparisons between ground cover types and surface temperature readings.

Carrying Out Investigations

- GLOBE protocols were used to measure the surface temperature of various ground covers
- The surface temperature is recorded in Celsius.
- Surfaces included were bare ground, short grass, and asphalt
- Each were measured at the same time.
- Multiple years of data were collected, including a wide range of months and seasons.
- Fits all data parameters needed for the research question to be explored.

Sites: Bare Ground (41.03833, -81.50096), Asphalt(41.03297 -81.50106), Short Grass(41.03781 -81.50113).



<https://www.google.com/maps/@41.0383443,-81.5020706,2912m/data=!3m1!1e3>

Results

Analyzing Data

Ten years of data was downloaded and analyzed. Measurements that did not include all three ground cover types were removed from the study, which left about 900 data entries. Google spreadsheets were used to organize the data that was needed to explore the question, "Does the ground cover type affect the surrounding surface temperature?" Next, each ground cover surface temperature was compared to see if there was a trend in temperature readings between the different surfaces.

- Celsius was used as the temperature unit.
- The data included measurements from 2006- 2017.

Figure 1

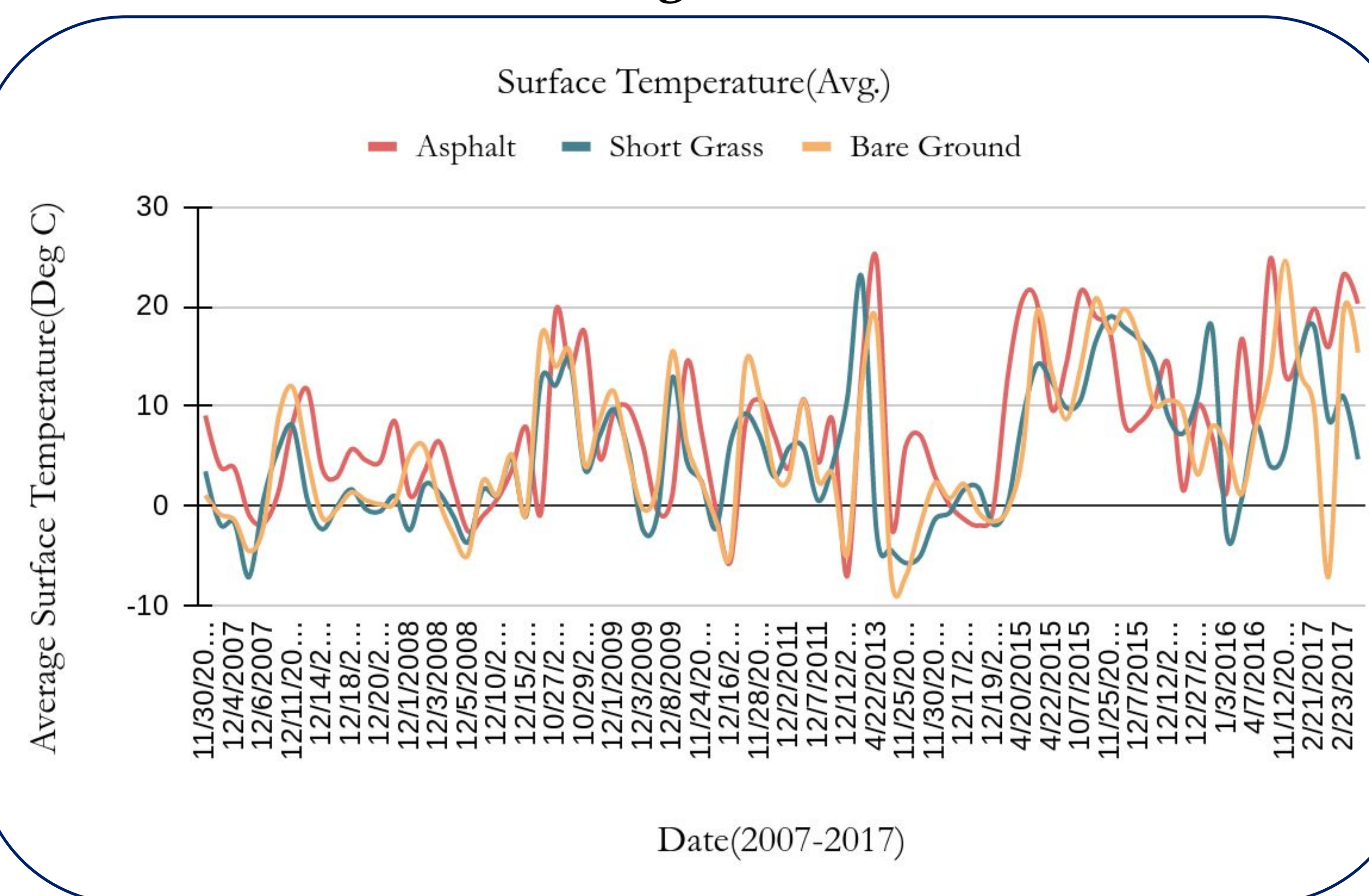
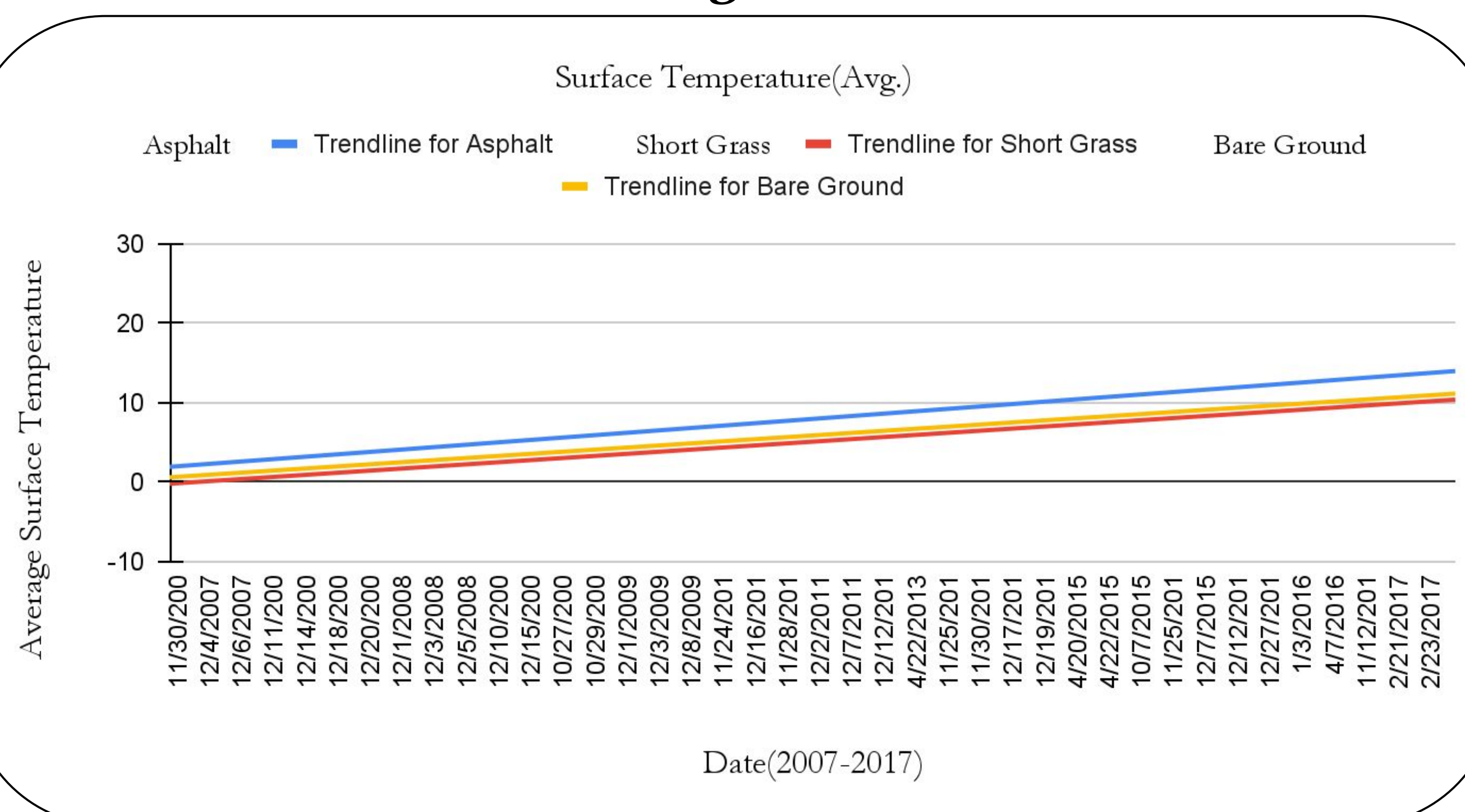


Figure 2



Graphs created by submitting students

Discussion

Interpreting Data

After analyzing over ten years of data, it is clear that the temperature decreases depending on the type of ground cover. Knowing the correct type of surfaces to use when creating new infrastructure can help decrease surface temperature, while also improving the planet's health and life on Earth.

The data provides evidence that supports how the type of ground cover affects the surface temperature. Between the different ground covers measured, the asphalt had the highest average surface temperature and the short grass had the lowest.

Wuhan, China tests how land use affects surface temperature. In their study, it shows how the more urbanized the land is, the higher the land temperature. In the study, they also check the surface temperature of cities surrounded by bodies of water to test if it'll have an effect. The study concluded that the highest land surface temperature is in suburban areas, while the lowest is in areas with high vegetation (Lu et al, 2021). In our data the short grass, which had the most vegetation, also had the lowest surface temperature.

Conclusions

Based on the data, the type of ground cover does affect the surrounding surface temperature. The data shows that asphalt ground covers had slightly higher surface temperatures than the natural surfaces. This was based on the average lower surface temperatures of short grass versus asphalt, with bare ground being in-between the two.

For future research, additional types of groundcovers could be explored to see which reduce the urban heat effect the most. Additional parameters like humidity, ambient temperature, and tree shade, using GLOBE protocols, could also be studied. Follow up research could be done exploring more places in the world.

We worked with two mentors for our project; our Science Olympiad coach and our GLOBE mentor from the University of New Orleans. They helped brainstorm ideas for research, showed us how to access the GLOBE advanced data tool and were able to assist with difficult parts of the data as well as answer any questions we had. This sped up the project and gave us a better understanding of our topic.

Bibliography

- By Earth Sphere (Protocols & Resources) - GLOBE.gov. (n.d.-a). <https://www.globe.gov/do-globe/globe-spheres>
- Lu, Y., Yue, W., & Huang, Y. (2021a). Effects of Land Use on Land Surface Temperature: A Case Study of Wuhan, China. *International Journal of Environmental Research and Public Health*, 18(19), 9987. <https://doi.org/10.3390/ijerph18199987>
- Reduce Urban Heat Island Effect | US EPA. (2023a, April 24). US EPA. <https://www.epa.gov/green-infrastructure/reduce-urban-heat-island-effect#:~:text=%22Urban%20heat%20islands%22%20occur%20when,heat%2Drelated%20illness%20and%20mortality.>
- Retrieve Data - GLOBE.gov. (n.d.-a). <https://www.globe.gov/globe-data/retrieve-data>